The Chair having been taken by Major Larcom,—

Dr. Apjohn made a communication, the object of which was to demonstrate the fallacy of the doctrine that, in order to produce a given volume of vapour, having a given elastic force, the same quantity of fuel must be consumed, irrespective of the nature of the liquids employed.

"It has been frequently proposed to substitute the vapour of some volatile liquid, such as alcohol or ether, for that of water in the steam-engine, under the idea that by so doing fuel would be economized; and the proposal appears *primâ facie* plausible, seeing that their boiling points are not only lower than that of water, but that the same is true of their specific heats, and of the latent heats of their vapours. This idea would seem to have struck at different times the minds of different persons, and the Rev. Mr. Cartwright, a gentleman of great mechanical genius, and celebrated for his mechanical inventions, actually devised a most ingenious form of steam-engine,* in which the piston was to be moved by the vapour of alcohol.

"Mr. Ainger, in a notice brought by him before the Royal Institution, London, in February, 1830, on the Economy of the Steam-Engine, would seem to be the first person who publicly dissented from such views; and he has certainly the merit of having shown the insufficiency of the data generally used by those who, previous to his time, calculated that the substitution of more volatile liquids for water would lead to a considerable saving of fuel. The conclusion, however, at which he arrives, that, leaving the original cost of the liquids out of consideration, water would be as economical a liquid as alcohol or ether, I believe to be quite erroneous; and as the question at issue is one of some practical importance, I shall proceed to state succinctly the method of calculation which I have employed in discussing it, and the precise results at which I have arrived.

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* See Philosophical Magazine, vol. I.

"As the vapours of different liquids have at their respective boiling points the same elastic force, equal volumes of them will produce equal mechanical effects. In order, therefore, to the solution of the question under consideration, it will only be necessary to calculate the weights of the different liquids, water included, which give equal volumes of vapours, and to determine the quantities of caloric necessary for the conversion of them into vapour.

"Now as the volume of a vapour, like that of any other form of matter, is represented by its weight or mass, divided by its specific gravity, if we put

$$\frac{x}{s'} = \frac{1}{s},$$

x being the weight of any vapour, whose specific gravity is s', and s the specific gravity of the vapour of water, we will get

$$x = \frac{s'}{s},$$

that is, the weight of any liquid which, at its boiling point, gives a volume of vapour equal to that given by a weight of water represented by unity at its boiling point, is got by dividing the specific gravity of the vapour by that of steam. But the specific gravities to be used in this computation are not those usually given in books, each of which is referred to a different unit, viz., air at the same temperature, and under the same pressure as the vapour, but the specific gravities of the vapours at the respective boiling points of the several liquids, compared to the standard unit, viz., air at 60°, and under a pressure of 30°. In the following Tables, the former specific gravities are found in the second, and the others in the third column, the latter being in each case got by multiplying the former by $\frac{518}{458 + t}$, t being the boiling point of the liquid which yields the vapour. In the fourth column we have the weights, which would

give equal volumes of vapours, calculated by the expression $x = \frac{s'}{s}$ already given, the values of s and s' being taken from the third column.

1.	2. Specific Gravity referred to air at Boiling points.	3. Specific gravity at Boiling points referred to air at 60°.	4. Weights, giving equal volumes of vapour.
Water, . .	.622	.480	1.000
Wood Spirit,	1.120	.950	1.979
Alcohol, . .	1.613	1.322	2.754
Ether, . . .	2.586	2.397	4.993

"It is now easy to assign the quantities of caloric necessary to produce an equal volume of the vapour of each liquid at their respective boiling points, for these will obviously be represented by the expression

$$mc\ \{(t - 50) + l\}$$

m being for each liquid its number in column 4, c its specific heat, t its boiling point, and l the latent heat of its vapour at the temperature of ebullition. When, with the aid of the annexed Table,—

	Boiling Points.	Specific Heats.	Latent Heats.
Water, . .	212°	1.00	961.8
Wood Spirit,	151.7	.67	475.2
Alcohol, . .	172.4	.64	374.4
Ether, . . .	100.4	.50	163.8

which exhibits the specific and latent heats on which most reliance can be placed, the numerical calculation is made, the following are the results:—

Water, . . .	1129	1.000
Wood Spirit, .	764.8	.676
Alcohol, . . .	875.5	.775
Ether, . . .	534.7	.473